GeoEngineers

January 17, 1989

Consulting Geotechnical
Engineers and Geologists

United Marine International Inc.
1441 Northlake Way
Seattle, Washington 98103

FEB 03 1989

Attention: Ms. Ruth Nelson

We are submitting two copies of our second draft of the Bottom Sediment Sampling Plan for the Yard 1 Dry Dock facility in Seattle, Washington. Development of the Sampling Plan is a joint effort of Unimar's consultants; GeoEngineers, FishPro, and Farr, Friedman & Bruya.

We received comments from Ecology, EPA and the Department of Natural Resources (DNR) regarding the first draft of the Sampling Plan during a meeting on December 19, 1988. Recommendations were made by the regulatory agencies for an additional background sample location in Lake Washington, for analyses of semi-volatile organic priority pollutant compounds (BNAs) in three on-site sediment samples, for bioassay testing of additional aquatic species, and for an additional on-site sample location to be used for offshore lease requirements of the DNR.

This second draft of the Sampling Plan includes most of the recommendations made by regulatory agencies in the December 19 meeting. However, the total number of on-site sample locations has been reduced to partially offset additional cost of analyses. The number of on-site sample locations has been reduced from seven to five, based upon PSDDA testing requirements. We estimate that 5300 cubic yards of sandblasting material is located beneath the Yard 1 facility and that approximately 20,000 cubic yards of sediment would be removed to dredge the sandblast waste (assuming an average dredge depth of 2 feet). PSDDA requires one chemical and biological profile for every 4000 cubic yards of contaminated sediment. In order to meet the PSDDA testing requirement the entire volume of material that may be removed, five on-site sediment samples have been selected. The sample locations have also been adjusted to meet the needs for evaluation of the DNR leased area.

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Biological investigation methods presented in the first draft of the Sampling Plan were discussed by the agency review committee and the project team. It was decided that the freshwater amphipod, Hyalella azetca, would be employed in bioassay tests on sediment from each station and Daphnia pulex would be employed in water column bioassays at the tributyltin sample station and the Lake Union control station. A recommendation was made by the regulatory review committee to use a freshwater midge as a second organism in the bioassay analyses.

Bioassays with the freshwater midge are not proposed by the project team. This organism has not been studied in Northwest regional sediment toxicity testing and there is no existing database for meaningful comparison. To compensate for the lack of data regarding other freshwater sediment bioassay organisms, we propose to perform an Apparent Effects Threshold (AET) analysis comparing sediment chemistry results to the broad AET database for marine organisms. This task would be done in consultation with the regulatory agencies. Bioassay results will be evaluated in conjunction with benthic population data and sediment chemistry characteristics to meet the Sediment Quality Triad investigative methodology preferred by the agencies.

We believe the modified Sampling Plan presented herein will be adequate for the project team to evaluate remedial options and environmental risks associated with the sediment at the Yard 1 Dry Dock facility.

We appreciate the opportunity to be of service to United Marine. Please call if you have any questions regarding this Sampling Plan.

Yours very truly,

GeoEngineers, Inc.

James A. Miller

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Principal

SEW:JAM:cs

File No. 1299-02-4

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Attn: Mr. James K. Farr

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Attn: Mr. James M. Thornton
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U.S.Environmental Protection Agency
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Washington State Dept. of Natural Resources
Attn: Dr. David W. Jamison

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BOTTOM SEDIMENT SAMPLING PLAN
UNIMAR YARD 1 DRY DOCK FACILITY
SEATTLE, WASHINGTON
FOR
UNITED MARINE INTERNATIONAL INC.

INTRODUCTION

The bottom sediment sampling plan for the Unimar Yard 1 Dry Dock facility is presented herein. The Yard 1 facility is located along the north shore of Lake Union in Seattle, Washington. The site location is shown relative to surrounding physical features in Figure 1. The Unimar facility was formerly owned and operated by Marine Power and Equipment (MPE). The facility is now operated by United Marine International, Inc. (Unimar). Dry dock facilities have been in operation at the site since the mid-1950s. Five dry docks are presently owned and operated at the Yard 1 facility by Unimar. The dry docks are used for ship construction and repair, which usually includes sandblasting and painting operations. Sandblasting grit and paint residue have accumulated on the bottom of Lake Union in and near the dry docks as a result of past operations and practices.

The Environmental Protection Agency (EPA) collected 137 bottom sediment cores at the Yard 1 facility to estimate the extent of the sandblasting material on the lake bottom. Sediment core logs, analytical results and bioassay results are presented in EPA's draft report "Marine Power and Equipment, Technical Status Report," dated March 3, 1987.

Additional sampling (32 sediment cores) and analysis of the bottom sediment was undertaken by MPE to further characterize the bottom sediments. The sediment core logs and analytical results for the MPE sampling are presented in GeoEngineers' "Report of Environmental Consultation, Bottom Sediment Conditions, Marine Power and Equipment, Yard 1 Dry Dock Facility, Seattle, Washington," dated June 1, 1988.

Approximately 5300 cubic yards of excess sandblasting material is estimated to be present on the lake bottom at the Yard 1 facility. The approximate distribution of the sandblasting material has been compiled from EPA and GeoEngineers reports and is presented in Figure 2.

PURPOSE

This sampling plan has been developed by Unimar and consultants from GeoEngineers, FishPro and Farr, Friedman & Bruya. Representatives from the Washington Department of Ecology (Ecology), the Washington Department of Natural Resources (DNR) and the EPA have provided guidance and review of the sampling plan.

The purpose of the sampling plan is to further characterize the chemical characteristics and toxicity of bottom sediment at the Yard 1 Dry Dock facility. The additional sampling efforts and analyses will provide the basis for a report evaluating the environmental risk associated with the sandblasting material. The final report will address three remedial options: (1) the no action alternative, (2) capping the contaminated sediment with clean material, and (3) dredging the contaminated sediment.

SAMPLE COLLECTION

Seven sediment cores will be collected for this sampling plan. Five of the cores will be taken at the Yard 1 facility and two cores will be taken at off-site locations in Lake Union and Lake Washington. Off-site sediment core sampling locations are shown in Figures 1 and 3.

Each sediment core will be collected with a stainless steel drive sampler operated by scuba divers. Additional sample volume will be collected for bioassay analyses using a stainless steel Ponar grab sampler. Samples will be split and discreet samples transferred into laboratory containers with stainless steel utensils. A chain of custody record will be filled out during sampling operations. The sampling equipment will be cleaned between samples using a trisodium phosphate wash solution followed by a distilled water rinse. Each sample core will be logged and photographed.

Water samples from the lake will be collected with a horizontal "Alpha" bottle located 1 foot above mudline at sample locations 1, 6 and 7. Sample handling and equipment cleaning will be as described for the sediment cores. Samples will be kept cool and delivered to the analytical laboratory the same day as collection. Bioassay splits will be kept cool and delivered to the biological laboratory within three days of sampling.

The anticipated sampling depths below mudline for each sample location are listed in Table 1. Each sediment core will be divided into several sub-samples for different analyses. Individual sub-samples are identified by the sample location number and a sequential letter. The proposed analyses for each sub-sample are listed in Table 2. The chemical and biological analyses listed in Table 2 are described in subsequent sections of this plan.

CHEMICAL ANALYTICAL METHODS

Samples of sediment, lake water and sediment interstitial water will be analyzed for various contaminants by Farr, Friedman & Bruya of Seattle, Washington. For the metals analyses, the appropriate method number from the Federal Register is listed along with the attainable detection limits in Table 3. In addition, selected sediment and water samples will be analyzed for tributyltin, leachable organic halogens, total petroleum

hydrocarbons, EP toxicity (metals), total metals, base/neutral and acid extractable organic priority pollutant compounds, and total polynuclear aromatic compounds. The method descriptions for these analyses are summarized below. In all cases, method blanks, sample duplicates (10 percent frequency), matrix spikes (10 percent frequency) and replicates will be run with the sediment samples during this project. One duplicate will be run for the water samples collected for the project.

Interstitial Water - Interstitial water from selected sediment samples will be collected in accordance with methods outlined in Appendix C of Tetra Tech (1986).

Sample preparation for interstitial water analysis will include centrifugation of the sediment at 6000 revolutions per minute for five minutes and filtering of the supernatant through a 0.45 um pore-size membrane filter. Analysis of the filtered sample will then be accomplished by the appropriate EPA method for the 11 target metals. The retained solid residue will be used for the EP toxicity analyses.

Modified EP Toxicity (EP TOX) - The EP TOX metals tests will be performed on air-dried sediment samples in accordance with EPA Method 1310. Interstitial water will be removed from the sediment sample by centrifuge. The sediment sample will be allowed to air dry for 60 days at room temperature prior to the analytical test. Target metals for the test include arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc. Detection limits will be 0.1 ppm.

Total Petroleum Hydrocarbons (TPH) - Total petroleum hydrocarbons will be analyzed by thin-layer chromatography methods. Detection limits will be 10 ppm.

Total Polynuclear Aromatics (PNAs) - PNAs will also be analyzed by the thin layer chromatography. Detection limits are expected to be 1 ppm.

Leachable Organic Halides (LOX) - LOX compounds will be leached from the soil with water and identified in accordance with EPA Method 9020 (modified). Detection limits will be 1 ppm.

Total Metals - Metals analyses for water and sediment will include: arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Detection limits and method numbers for the analyses are summarized in Table 3.

Metals Screen - Screening of sediment by testing for indicator metals compounds will be performed on several sediment samples. The metals screen will be used to distinguish the contaminant profile with depth. The indicator metals include cadmium (Method 7130), lead (Method 7420) and zinc (Method 7950).

Base/Neutral Acid Extractable (BNAs) - Base/neutral acid extractable compounds (semi-volatile organic compounds) will be analyzed in accordance with EPA Method 8270. Detection limits for each compound are described in the EPA method description.

Tributyltin (TBT) - The presence of TBT will be analyzed in the two Lake Union water samples and one interstitial water sample by either gas chromatography/mass spectrometry (GC/MS) or gas chromatrography/Flame Photometry (GC/FP) techniques in accordance with the analytical procedures described by Varanaski, et al. (1988). Detection limits will be 0.01 ppb.

BIOLOGICAL INVESTIGATIONS

The purpose of this work effort is to quantify and describe the extent and biological consequence of sandblast grit pollution at the Unimar (formerly MPE) shipyard on Lake Union. Two approaches will be used in this assessment: the Sediment Quality Triad (Long and Chapman, 1985) and the Apparent Effects Threshold Analysis (Barrick, et al. 1985). The ultimate goal is to determine existing benthic environmental conditions at the site with respect to sandblast grit pollution and to make recommendations for remedial action alternatives.

The Sediment Quality Triad approach entails a three-way assessment of the study area. Sediment chemistry, benthic invertebrate community structure, and bioassay analysis are the three independent but interrelated tests that form the triad. This approach requires discreet sediment samples split between all three evaluations to provide data sets for each sample station that describe the pollution extent and toxicity at each station.

Currently, Apparent Effects Threshold (AET) values for freshwater sediments are not available. However, marine data describing biological effects to sediment pollutant concentrations are extensive for a variety of organisms and will be compared to the sediment chemistry results from the Unimar site. A detailed description of the AET analysis is found in Barrick, et al., (1988).

METHODOLOGY

Sample station locations within the Unimar shipyard area are discussed in previous sections. These same five on-site stations will be sampled for benthic community structure assessment and bioassay test material. Two control stations will also be sampled. Station 6 in central Lake Union and Station 7 in Lake Washington (Figures 1 and 3). These stations were selected to illustrate background toxicity levels in Lake Union and at a site in Lake Washington that exhibits similar depth and grain-size characteristics.

The methodology developed for this assessment was derived from several literature sources with regulatory agency input. Due to the relatively recent biological assessments performed at Gas Works Park (Yake, et al., 1986) similar techniques and protocol are proposed to insure comparable results to better assess the Lake Union ecosystem. Sampling and testing methods will closely follow guidelines set in Puget Sound Dredge Disposal Analysis (Clarke, 1986), The Puget Sound Protocols (Tetra Tech, 1986), the American Society for Testing and Materials (ASTM) (Nelson et al., 1988), and EPA methods for freshwater toxicity measurements (Peltier and Weber, 1985; Horning and Weber, 1985).

BENTHIC COMMUNITY DETERMINATION

A minimum of three benthic grab samples will be obtained from each station to a depth of 5 cm. A stainless steel Ponar dredge will be used to collect these sediments. Each sample will be split in the field for triad assessment requirements. The benthic community sample will be sieved in the field. The upper 2 cm of the substrate will be gently washed through a 0.25 mm sieve. The remaining portion of each sample will be sieved through a 1.0 mm and 0.5 mm sieve stack. The material retained on the screens will be preserved in 5 percent buffered formalin stained with Rose Bengal and transported to the laboratory for identification to the lowest practical taxonomic level. All organisms will be identified, enumerated and preserved for potential future use. Standard biological observations will be recorded at the time of sampling. Minimum observations will include: location, time, weather, sample depth, water temperature, dissolved oxygen, pH, sample disturbance, substrate characteristics and biological material (burrow, tubes, shells, etc.).

BIOASSAY ANALYSIS

Sediment will be transferred into glass containers and cooled in the field at $4^{o}C$. Bioassay protocols and QA/QC procedures have been developed by ASTM and are available in Nelson, et al. (1988). These protocols are expected to be approved as ASTM Standards in February 1989. All bioassay methods for this work effort will strictly adhere to these guidelines using the freshwater amphipod Hyalella azteca as the test organism at all stations. The bioassay will be conducted over 28 days. Survival, growth, and reproduction will be observed as endpoints to the bioassay.

At Station Nos. 1 and 6 a water sample will be obtained using an "Alpha" horizontal sampler. The water samples will be collected 1 foot above the sediment surface. Water collected at this station will be tested for tributyltin and used in a static water bioassay employing Daphnia pulex as the test organism. Controls for this test will be normal and spike control conditions. Daphnia bioassays will follow a ten day schedule with survival as the endpoint.

All bioassays will be run in replicates of five (5) to achieve the desired level of statistical sensitivity. Ten (10) organisms will be placed in each test chamber. Data will be statistically analyzed using a variety of analysis of variance techniques.

APPARENT EFFECTS THRESHOLD ANALYSIS

Sediment chemistry results will be compared to the marine sediment AET values. This comparison, in conjunction with results of the benthic community and bioassay tests, will help to identify the pollutant or group of pollutants that most likely are responsible for any observed biological effects. This work may require input from the involved regulatory agencies to insure a comparable analysis.

LITERATURE CITED

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Yake, B., Norton, D. and M. Stinson, October 1986. Application of the Triad Approach to Freshwater Sediment Assessment: An Initial Investigation of Sediment Quality Near Gas Works Park, Lake Union. Water Quality Investigations Section, Washington Department of Ecology, Olympia, Washington.

TABLE 1

SUMMARY OF SAMPLING PLAN

Sample Location Number	Type of Sample	Anticipated Sampling Depth Below Mudline (ft)	Sampling Technique	Anticipated Thickness of Sandblasting Material (ft)	Comments
1	Sediment	4	Gravity core/ Ponar Grab	2.0	
1	Water	-	Alpha bottle	-	Collect water sample 1 foot above mudline
2	Sediment	4	Gravity core/ Ponar Grab	0	
3	Sediment	4	Gravity core/ Ponar Grab	0.2	
4	Sediment	4	Gravity core/ Ponar Grab	0	
5	Sediment	4	Gravity core	0.2	
6	Sediment	4	Gravity core/ Ponar Grab	0	"Background" Lake Union bottom sediment sample
6	Water	-	Beta bottle	-	Collect water sample 1 foot above mudline
7	Sediment	4	Gravity Core/ Ponar Grab	0	"Background" Lake Washington bottom sediment sample
7	Water	-	Alpha bottle	-	Collect water sample 1 foot above mudline

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TABLE 2

SUMMARY OF ANALYTICAL PLAN

Sample Number	Type of Sample	Subsample Interval (ft)	Total Petroleum Hydrocarbons	Total PNAs	Total BNAs	LOX Screen	Modified EP Tox	Total Metals	Metals Screen	TBT	Daphnia Bioassay Analyses	Amphipod Bioassay Analysis
1A	Water	1' above mudline						x		x	x	
1B	Sediment	0 - 0.2	x	x	x	x	x	x				x
1C	Interstitial water	0.2 - 2.0						x		x		
1D	Sediment	0.2 - 2.0	x	x		x	x	x				
1E	Sediment	2.0 - 2.5							x			
1F	Sediment	2.5 - 3.0	x	x					x			
1G	Sediment	3.5 - 4.0							x			
2A	Sediment	0 - 0.2	x	x	x	x	x	x				x
2B	Sediment	0.2 - 0.5							x			
2C	Sediment	0.5 - 1.0							x			
2D	Sediment	1.0 - 1.5							x			
2E	Sediment	1.5 - 2.0							x			
2F	Sediment	2.0 - 2.5							x			
2G	Sediment	2.5 - 3.0							x			
2H	Sediment	3.0 - 3.5							x			
2I	Sediment	3.5 - 4.0							x			
3A	Sediment	0 - 0.2	x	x		x		x				x
3B	Sediment	0.2 - 4.0	x	x				x				
4A	Sediment	0 - 0.2	x	x	x	x		x				x
4B	Sediment	0.2 - 4.0	x	x				x				
5A	Sediment	0 - 0.2	x	x		x		x				x
5B	Sediment	0.2 - 4.0	x	x				x				
6A	Water	1' above mudline						x		x	x	
6B	Sediment	0 - 0.2	x	x	x	x	x	x				x
6C	Interstitial water	0.2 - 2.0						x		x		
6D	Sediment	0 - 0.5	x	x		x	x		x			
6E	Sediment	0.5 - 1.0							x			
6F	Sediment	1.0 - 1.5	x	x					x			
6G	Sediment	1.5 - 2.0							x			
6H	Sediment	2.0 - 2.5							x			
6I	Sediment	2.5 - 3.0							x			
6J	Sediment	3.0 - 3.5							x			
6K	Sediment	3.5 - 4.0							x			
7A	Sediment	0 - 0.2	x	x		x		x				x
7B	Sediment	0.2 - 4.0	x	x		x		x				
		T O T A L S	15	15	4	10	5	16	19	4	2	7

TABLE 3

SUMMARY OF ANALYTICAL METHODS

Compound/ Element	Sediment		Water	
	Method Number	Detection Limits (ppm)	Method Number	Detection Limits (ppm)
Arsenic	7060	50	7061	0.05
Barium	7080	10	7081	1.0
Cadmium	7130	0.5	7131	0.01
Chromium	7190	50	7191	0.05
Copper	7210	50	7211	1.0
Lead	7420	50	7421	0.05
Mercury	7470	0.1	7471	0.002
Nickel	7520	20	7521	1.0
Selenium	7740	1.0	7741	0.01
Silver	7760	1.0	7761	0.05
Zinc	7950	100	7951	5.0

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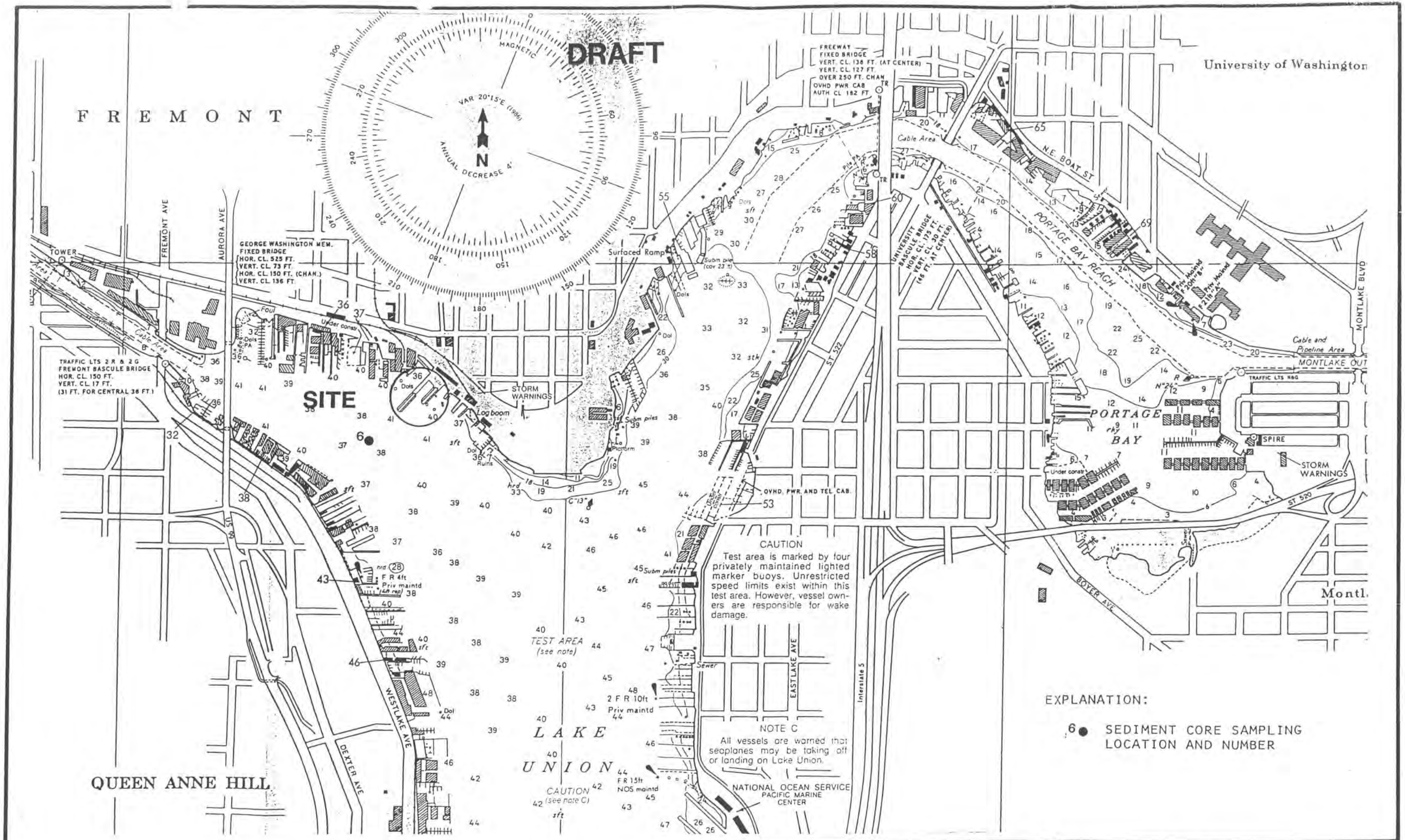

REFERENCE: NOAA NAUTICAL CHART 18447 ENTITLED "LAKE WASHINGTON SHIP CANAL AND LAKE WASHINGTON.".

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SITE LOCATION

FIGURE 1

1299-02-4 SEW:KKT 11-22-88

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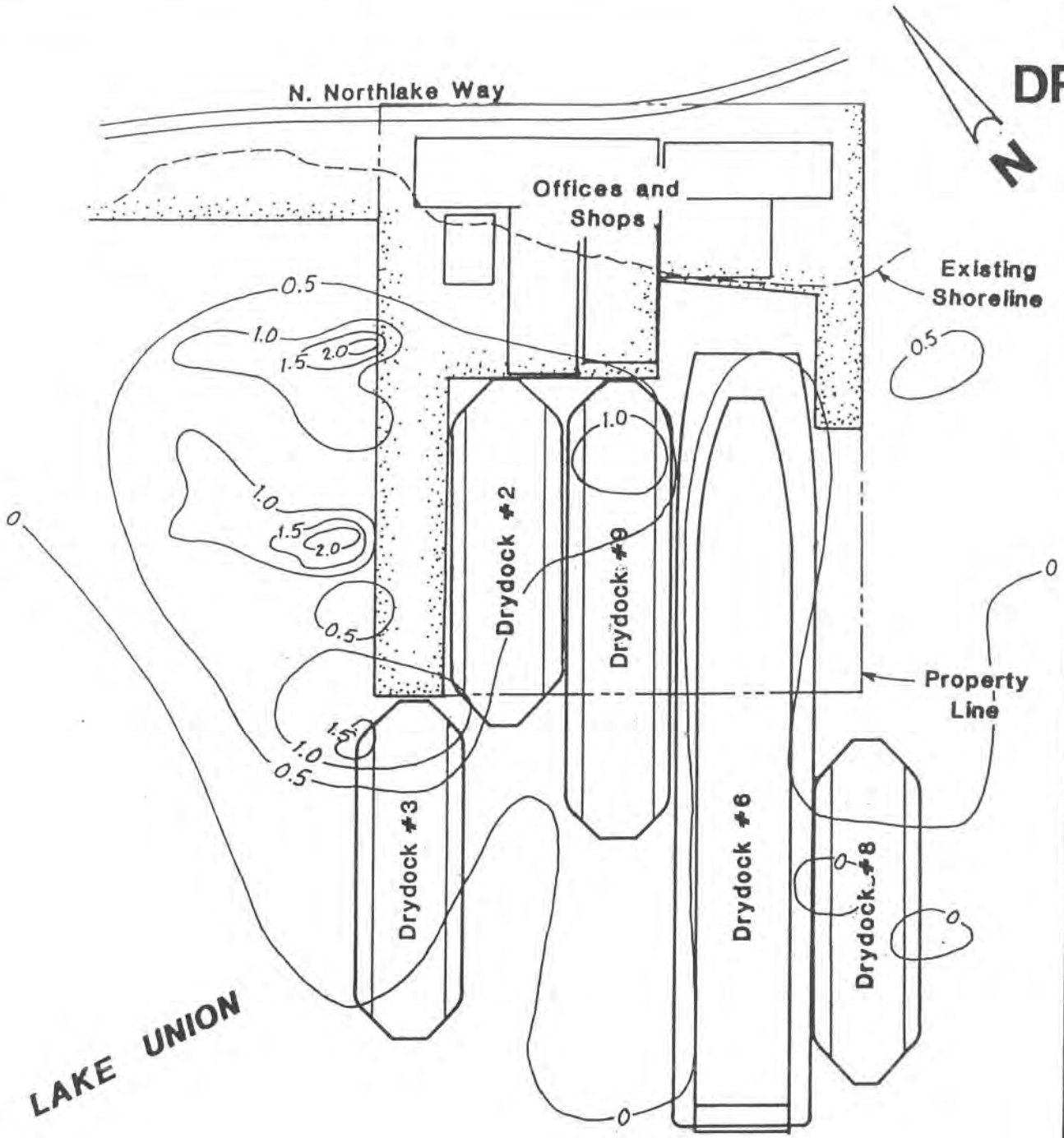

EXPLANATION:

0.5 THICKNESS CONTOUR OF SANDBLASTING MATERIAL

0 100 200

SCALE IN FEET

REFERENCE:

UNTITLED DRAWING PROVIDED BY MARINE POWER & EQUIPMENT, INC., DATED 1-12-86.

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DISTRIBUTION OF SANDBLASTING MATERIAL

FIGURE 2

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LAKE WASHINGTON

Sand Pt

Pontiac Bay

Wolf Bay

Ramp

2 F R Lts Priv maintd PA

Hunt Pt

Boddy Cozy Cove

Fairweather Bay

Evergreen Pt

EVERGREEN POINT ROAD

E FIXED SPAN HOR CL 207 FT VERT CL 57 FT

NOTE B
Submerged mooring cables in this area.

Medina

Dabney Pt

Eastland

Great Pt

HALF-MILE MARKER (see note B)

MEASURED NAUTICAL MILE COURSE 102°-30' TRUE

PONTOON BRIDGE HOR CL 100 FT (BEING RECONST)

Cable Area

WEBSTER PT

W FIXED SPAN HOR CL 206 FT VERT CL 44 FT

MADISON PARK

MADISON ST

Laurelhurst

Hospital

CROSS

TANK

UNION BAY

UNION BAY BEACH

Foster Island

WASHINGTON PARK

Ravenna

35TH AVE NE

35TH AVE

1ST

MAGNETIC

VAR 20°15'E (1986)

ANNUAL DECREASE 8'

N

SEATTLE

MADRONA PARK

1299-02-4 SEW:KKT 1-6-89

REFERENCE:

NOAA NAUTICAL CHART 18447 ENTITLED "LAKE WASHINGTON SHIP CANAL AND LAKE WASHINGTON".

EXPLANATION:

7● SEDIMENT CORE SAMPLING LOCATION AND NUMBER

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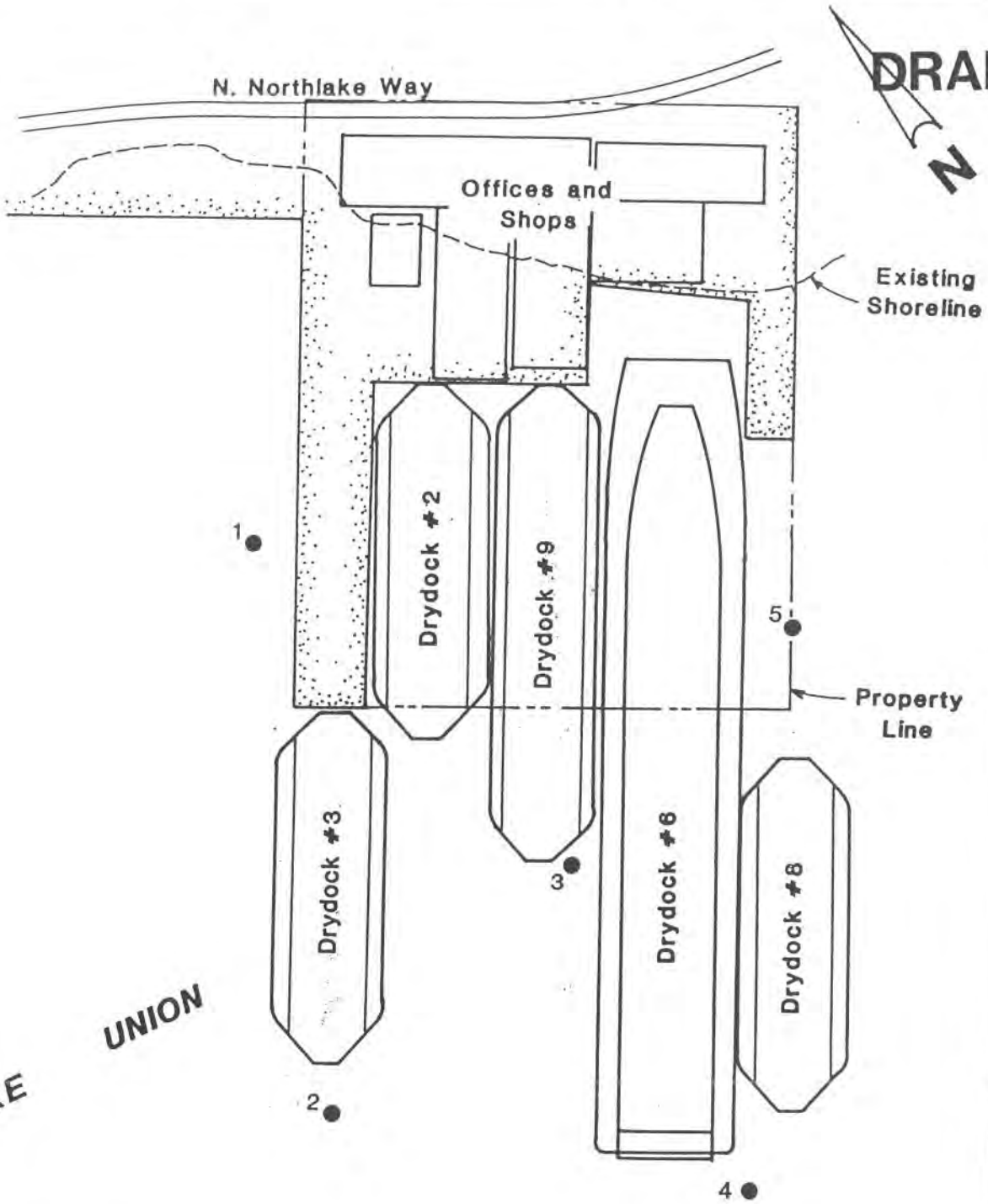
LAKE WASHINGTON SEDIMENT SAMPLE 7

FIGURE 3



EXPLANATION:

1 ● SEDIMENT CORE SAMPLING LOCATION AND NUMBER

0 100 200

SCALE IN FEET

REFERENCE:

UNTITLED DRAWING PROVIDED BY MARINE POWER & EQUIPMENT, INC., DATED 1-12-86.

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SEDIMENT SAMPLE LOCATIONS

FIGURE 4

1299-02-4 SEW:KKT 11-17-88 Rev. 1-6-89 KKT